

3-C
PROJECT DESCRIPTION:
OUTFALL

**FINAL
ENVIRONMENTAL
IMPACT STATEMENT**

**Brightwater
Regional Wastewater
Treatment System**

APPENDICES

Final

Appendix 3-C

Project Description: Outfall

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1.0 INTRODUCTION

King County has prepared a Draft Environmental Impact Statement (Draft EIS) (King County, 2002a) and Final Environmental Impact Statement (Final EIS) on the Brightwater Regional Wastewater Treatment System. The Final EIS is intended to provide decision-makers, regulatory agencies and the public with information regarding the probable significant adverse impacts of the Brightwater proposal and identify alternatives and reasonable mitigation measures.

King County Executive Ron Sims has identified a preferred alternative, which is outlined in the Final EIS. This preferred alternative is for public information only, and is not intended in any way to prejudge the County's final decision, which will be made following the issuance of the Final EIS with accompanying technical appendices, comments on the Draft EIS and responses from King County, and additional supporting information. After issuance of the Final EIS, the King County Executive will select final locations for a treatment plant, marine outfall and associated conveyances.

The County Executive authorized the preparation of a set of Technical Reports, in support of the Final EIS. These reports represent a substantial volume of additional investigation on the identified Brightwater alternatives, as appropriate, to identify probable significant adverse environmental impacts as required by the State Environmental Policy Act (SEPA). The collection of pertinent information and evaluation of impacts and mitigation measures on the Brightwater proposal is an ongoing process. The Final EIS incorporates this updated information and additional analysis of the probable significant adverse environmental impacts of the Brightwater alternatives, along with identification of reasonable mitigation measures. Additional evaluation will continue as part of meeting federal, state and local permitting requirements.

Thus, the readers of this Technical Report should take into account the preliminary nature of the data contained herein, as well as the fact that new information relating to Brightwater may become available as the permit process gets underway. It is released at this time as part of King County's commitment to share information with the public as it is being developed.

2.0 PURPOSE

The objectives of this Technical Memorandum are to summarize the outfall siting process and describe the current level of outfall planning and design for each of the Brightwater System alternatives. For any of the three Brightwater System alternatives, outfall construction has been proposed to discharge the treated effluent into Puget Sound. Other effluent flow management strategies, such as stream flow augmentation and groundwater discharge, were evaluated and deemed impractical due to cost considerations and discharge method limitations as summarized in the *Uplands Discharge Technical Memorandum* (King County, 2003a). Descriptions of the plant and conveyance components of the Brightwater System are the subject of separate Technical Memoranda.

3.0 OUTFALL DESCRIPTION SUMMARY

The outfall will consist of a pipeline starting on land and continuing underwater. A diffuser at the end of the pipeline will disperse the effluent into Puget Sound through small holes (ports) spaced along its length. The outfall will be sited and designed to provide strong mixing and dilution of the effluent, be protective of water quality standards and the health of Puget Sound, minimize impacts to area residents and commercial enterprises, and maintain proper hydraulic performance over the design life of the outfalls.

Two areas, called outfall zones, have been identified as potential locations for the placement of the Brightwater Outfall. Each outfall zone extends approximately 7,500 feet into Puget Sound from the Sound's eastern shoreline in northern King County and southern Snohomish County. Outfall Zones 6 and 7S, as shown in Figure 1, were selected on the basis of data collected during outfall siting studies and an evaluation of 29 factors as described in the *Brightwater Phase 3 Draft EIS, Conveyance Evaluation Summary* (King County, 2002b). The factors address scientific, engineering, and societal concerns involving construction and operation of a marine outfall in Puget Sound. Outfall Zone 7S will be utilized if the alternatives associated with the Route 9 treatment plant are selected. Outfall Zone 6 will be utilized if the Brightwater treatment plant is located at the Unocal site.

Potential outfall alignments, pipeline routes from the shoreline to the diffuser location, have been identified within both Zones 6 and 7S in Figures 2 and 3, respectively. The preferred outfall alignment in Zone 7S will originate from a conveyance portal located at Point Wells. The preferred outfall alignment in Zone 6 will originate from the effluent pump station located at the Unocal treatment plant site.

Along the potential outfall alignments, the pipeline will be installed through several areas of differing seafloor slope and environmental resources. In general, a relatively flat shelf where environmental resources are most dense extends approximately 500 to 2,000 feet offshore. Beyond the shelf, the seafloor slope increases (up to 35 percent) before reaching the main channel area of Puget Sound approximately 5,000 feet offshore. Diffusers will be located in the generally flat central channel area at water depths of approximately –600 feet mean lower low water (MLLW). For purposes of outfall discussion and evaluation, the flat shelf area will be called the “nearshore.” Any area west of the shelf will be called “offshore.” Areas inland (east) of the nearshore area will be called “onshore.”

Applicable outfall construction methods and activities differ for the onshore, nearshore, and offshore areas. Two construction methods (open trench and trenchless¹) have been evaluated for installation of the outfall pipeline onshore and through the nearshore. Both open-trench and trenchless construction methods would bury the outfall pipeline below the seafloor surface and protect the pipeline from wave, erosion, and anchor damage. Open-trench construction is preferred for installation of the onshore and nearshore outfall segments. As discussed in the *Nearshore Alignment and Construction Alternatives Technical Memorandum* (King County, 2003b), open-trench construction is a proven construction method for outfall installation in the Puget Sound and is less sensitive to potential subsurface barriers than trenchless construction. Three construction methods (segmental lay, controlled submergence, and bottom pull) may be utilized to install the offshore pipeline. All of the offshore construction methods will place the outfall pipeline directly on the seafloor.

¹ “Trenchless” is a general tunnel construction term that includes such tunneling methods as conventional tunnel, microtunnel, and horizontal directional drill.

4.0 OUTFALL DESIGN ISSUES AND CRITERIA

Location (siting) of the outfall diffuser should avoid areas with unstable or irregular seafloor slopes. Outfall siting should be protective of marine plant and animal life, human health, and water quality standards, and minimize impacts to surrounding land use, recreation, and public services. Once a suitable location has been selected, design should focus on the materials, construction methods, and hydraulic performance for a properly functioning marine outfall. The outfall siting process and current level of design are summarized in subsequent sections of this Technical Memorandum.

Marine outfalls typically terminate in multiport diffusers that promote rapid dilution of effluent with ambient marine waters in order to meet dilution, effluent transport, and hydraulic performance goals. Upon discharge, the momentum of effluent exiting diffuser ports results in vigorous mixing with ambient seawater. As this “jet-momentum” starts to dissipate, the buoyancy of the effluent provides further mixing as the plume rises through the water column due to a difference in effluent plume and receiving water density. Sufficient dilution may occur at depth such that the diluted effluent becomes denser than the overlying surface water and is subsequently trapped below the surface. The diluted effluent then forms a waste field around this trapping depth, which is then spread and advected laterally by currents and eddies generated by wind, tides, estuarine transport mechanisms, and bathymetric features.

The dilution and effluent transport criteria identified by King County that impact siting and design of the Brightwater Marine Outfall include the following:

- Achieve minimum dilution of 100:1 at the chronic mixing zone boundary at maximum month flow and 30:1 at the acute mixing zone boundary at peak instantaneous flow.
- Maintain trapping depth below –70 feet MLLW at maximum month flow.
- Minimize potential for effluent reflux², contact with human receptors, contact with fisheries, and other aquatic habitat, and contact with the shoreline.
- Meet Washington State Marine Water Quality Criteria for protection of aquatic and human health.
- Other operational and maintenance criteria include:
 - Protect diffuser from potential seismic events and submarine slides.
 - Maintain acceptable hydraulic performance at all Brightwater System flows.
 - Minimize need to access diffuser for maintenance.

² Long term effluent accumulation in the receiving water near the outfall due to ebb and flood tidal cycles.

5.0 OUTFALL SITING AND DESIGN PROCESS

In 1999, siting and environmental studies were initiated to characterize the existing environment within the project area and facilitate the siting and design of the Brightwater Marine Outfall. The siting process proceeded through three increasingly focused phases of evaluation, culminating in the selection of outfall Zones 6 and 7S (see Figure 1) as part of the overall Brightwater System.

In Phase 1, three constraints were identified that, if present, would seriously limit construction or operation of the marine outfall. These constraints included presence of a Superfund site (designated under the Comprehensive Environmental Response, Compensation, and Liability Act [CERCLA]), presence of anchor zones, and minimum required diffuser depth. No Superfund sites or anchor zones were identified in the study area, which extended from Mukilteo State Park to Shilshole Bay. The minimum diffuser depth required to meet regulatory dilution standards was estimated to be 100 feet.

After initial identification of unconstrained sites, the study team determined the presence of geophysical constraints such as steep slopes; presence of submarine canyons, ridges and slides; and unsuitable substrate for tunneling. Next, the study team examined nearshore biological, shoreline public use, and hazardous materials constraints in those areas not already constrained by geophysical issues. After compiling all the information, eight unconstrained preliminary outfall zones were identified in Phase 1; two of which had both north and south subareas, yielding a total of ten areas that were evaluated and ranked. A complete description of the methodology used in applying the site screening criteria (Detailed Evaluation Questions “DEQs”), can be found in *Detailed Evaluation Questions Marine Outfall Siting Study* (King County, 2001a).

In Phase 2, the DEQs developed to evaluate outfall alternatives addressed engineering, environmental, community (neighborhood effects), and financial policy considerations. The methodology and results of the Phase 2 evaluation are presented in *Phase 2 Detailed Evaluation Questions* (King County, 2001b) and *Application of Phase 2 Detailed Evaluation Questions* (King County, 2001c). All eight outfall zones identified in Phase 1 were found to be suitable. However, Zones 1 through 4 and Zone 8 (along with their associated diffuser sites) were eliminated from further consideration based on the geographic distance between these zones and the proposed land-based treatment facility and conveyance routes. These geographically distant outfall zones would be burdened with the additional costs of a longer conveyance route without providing significant benefits in terms of outfall and diffuser performance.

Five diffuser sites in four candidate outfall zones (Zones 5, 6, 7N, and 7S) were evaluated further in Phase 3. The Phase 3 evaluation was supported by updated plume modeling and water quality analyses, workshops assessing outfall construction methods and potential construction risks, and conceptual level outfall design. Conceptual level design, presented in the *Brightwater Marine Outfall Conceptual Design Report* (King County, 2002c), led to the development of conceptual outfall alignments for each of the candidate diffuser sites and potential methods of outfall pipeline construction. The outfall alignments developed during conceptual design represented feasible pipeline alignments and provided the basis for estimating pipe length, potential slope conditions, and other design parameters. The outfall alignments were differentiated by two general construction methods for crossing the nearshore area; tunnel and trench.

The remaining candidate outfall zones, conceptual outfall alignments, and construction methods were then evaluated using a matrix of 29 factors developed by King County and the project team and documented in *Brightwater Phase 3 DEIS Conveyance Evaluation Summary* (King County, 2002b). Although all of the candidate outfall zones were viable alternatives, the evaluation indicated that some outfall zones presented a more practical alternative relative to others. Differences among zones were related to the amount of land available for construction and the amount of disruption that would result from the construction and operation of the outfall. These include possible disruptions to commercial activity and the biological resources of Puget Sound. Based on these analyses, and in consideration of the plant and conveyance components of the Brightwater System, Outfall Zones 6 and 7S were selected as alternative outfall zones and were presented in the Brightwater Draft EIS (King County, 2002a).

Since publication of the Draft EIS, outfall predesign efforts have focused on further evaluation of nearshore construction methods and diffuser design characteristics. An evaluation of nearshore construction methods and potential outfall alignments are presented in the *Nearshore Alignment and Construction Method Alternatives Technical Memorandum* (King County, 2003b). The Technical Memorandum recommends preferred construction methods and outfall alignments originating from potential conveyance tunnel terminus locations for the Route 9 plant site (outfall Zone 7S) and from the Unocal plant site (outfall Zone 6). Diffuser design characteristics, such as length and location, were recommended in the *Diffuser Predesign Technical Memorandum* (King County, 2003c) based on updated, site-specific bathymetric and geophysical surveys.

The project description presented herein is updated from the Draft EIS Project Description and is based on the current level of engineering design. Project description elements discussed in the subsequent sections include:

- Construction Methods.
- Connection to Plant and Conveyance Brightwater System Components.
- Outfall Alignments and Segment Lengths.
- Diffuser Design.
- Pipeline Size and Materials.
- Construction Excavation and Backfill Materials.
- Construction Duration.
- Outfall Operation and Maintenance.

6.0 OUTFALL CONSTRUCTION METHODS

Open-trench construction is preferred for installation of the onshore and nearshore outfall segments. Although not the preferred construction method, trenchless construction methods are viable for installation of the outfall pipeline onshore and through the nearshore. Trenchless construction is not the preferred method because impassable barriers, such as piles, logs, and boulders, have created difficulties for a significant number of similar land-based tunnel projects in the Puget Sound region. (Tunnel construction under Puget Sound has not yet been attempted.) The barriers, if encountered, may necessitate abandonment of the tunnel alignment or excavation of a shaft to provide access to the tunneling face and remove the barrier. Abandonment of the tunnel or excavation of a shaft would significantly increase construction costs and could potentially create significant environmental impacts.

6.1. Onshore and Nearshore Construction Methods

Open-trench and trenchless construction methods for installation of the onshore and nearshore outfall pipeline segments were evaluated in the *Nearshore Alignment and Construction Method Alternatives Technical Memorandum* (King County, 2003b). Factors impacting selection of the construction method include construction risks, staging area characteristics, length of the nearshore outfall segment, environmental resources along the alignment, and the presence, if any, and extent of contamination. Based on an evaluation of these factors, open-trench construction was selected as the preferred construction method for outfalls in both Zones 6 and 7S.

6.1.1. Open-Trench Construction

Open-trench construction methods will be utilized for both onshore and nearshore outfall pipeline segments. Open-trench construction on land and through the nearshore includes excavation of the trench, pipeline installation, trench backfilling and pipeline protection, and restoration of the trench surface. If required, trench shoring (sheeting) could also be installed ahead of the trench excavation to minimize the width of the trench. Use of sheeted trench construction onshore is preferred to minimize the volume of excavation in areas of potential soil and groundwater contamination. Groundwater control methods in addition to trench sheeting and dewatering will be evaluated during final design. Use of sheeted trench construction in nearshore areas up to -30 feet MLLW would be used to minimize environmental impacts in areas of sensitive nearshore habitat.

6.1.1.1. Trench Sheeting

Sheet piles are driven into the seafloor or ground surface to minimize trench section width and prevent surrounding soil and sediment from sloughing into the trench during excavation. During nearshore construction, trench sheeting will extend above the seafloor and could, at the contractor's option, extend to or above the water surface. Extension to the water surface would make the trench more visible and should decrease the time required for construction. After pipe installation and backfill, the trench sheets would be removed.

The most common types of equipment used to install sheet pile walls are vibratory hammers and impact hammers. Vibratory hammers are widely used because they usually can drive the sheet piles faster, do not damage the top of the pile, and can easily extract the piles after the pipeline is installed.

As identified by preliminary geotechnical and geophysical explorations (King County, 2001d), open-cut or sheet pile trench construction through the nearshore will generally encounter loose to compact granular soils to the depth of the required excavation (up to 15 feet). These materials should not present any unusual or difficult construction problems for trench excavation or sheet pile installation. The composition and density of the materials will impact the stability of open-cut slopes and the width of the excavation section. Soils encountered during onshore trench construction (up to 30 feet deep) are not anticipated to impact excavation.

Unsheeted trench installation through the nearshore could disturb a width of 60 to 100 feet along the length of the pipeline. Nearshore sheeted trench installation could reduce the seabed impact to approximately a width of 20 to 25 feet along the length of the pipeline. The width of onshore sheeted trench construction would be approximately 10 to 12 feet. See Figure 4 for cross-sections of sheeted and unsheeted trench construction.

6.1.1.2. Staging Area

Trench construction activities up to the shoreline will originate from a land-based staging area near the potential conveyance tunnel portal in Portal Siting Area 19 for outfall construction in Zone 7S and near the Unocal plant site effluent pump station for outfall construction in Zone 6. Excavation, pipeline installation, and backfilling will proceed simultaneously along a stretch of the alignment. When the work for one stretch is complete, the equipment would be moved forward to work in the next area and the area behind would be backfilled.

Activities at the on-land staging area could include assembly of pipeline structures, loading and unloading of trucks carrying materials, storage of construction materials, and storage of construction machinery. The staging area could also hold construction offices for King County and contractor personnel. The staging area could be in use for the duration of onshore, nearshore, and offshore construction.

Trench construction through the nearshore will be supported by barge-mounted construction equipment. Barge supported trench excavation would require a “working barge” along with several support barges. Tugboats would be used for moving barges to and from the site and for positioning of the working barge. The working barge would be equipped with a crane for laying pipeline segments and excavating the trench. The support barges would be used to supply the working barge with pipeline segments and backfill material while additional barges could store excavated soils for use as backfill or transport to the disposal site.

The working barge will be anchored to the seafloor with “spuds.” Spuds act like pins sticking into the seafloor below the barge and can be used up to water depths of approximately –60 feet MLLW. Spuds can be raised and lowered to allow movement of the working barge. Typically the barge would be pushed into shallow water by working tugs. Two anchors would be placed offshore to allow positioning “pull.” The spuds are then utilized to allow control of the angular position of the barge relative to the trench direction. Since the spuds move up and down vertically from the barge, no additional footprint space would be required. However, the spuds could cause additional damage to the seafloor itself. Penetration of the spuds into the seafloor may reach 3 or 4 feet, depending on soil conditions. For barges supplying the working barge, or for barges working beyond water depths of –60 feet MLLW, four to six anchor lines could be

used. Anchor lines extend from the barge in several directions and are typically up to 1,000 feet long.

6.1.1.3. Construction Machinery and Equipment – Onshore

The primary types of equipment used for onshore trench excavation and pipeline installation include excavators, backhoes, dump trucks, front-end loaders, flatbed delivery trucks, cranes, vibratory compactors, and dewatering equipment. Pavement breaking and repavement equipment may also be required in onshore areas with existing pavement. Artificial lighting equipment would be required for early morning or late afternoon operation during typical trench construction hours (7:00 a.m. to 7:00 p.m.).

Jack and bore construction equipment may be required in conjunction with trench construction equipment for short (up to 500 feet) crossings of special facilities such as railroads, major utilities, or potentially the seawall at Point Wells where interruption of these facilities may be undesirable. The method involves use of a horizontal boring machine or auger to drill a hole under the crossing. As the bore is advanced, the pipe is pushed, or “jacked” into the hole using a hydraulic jack positioned in a launch pit at one end of the crossing. Microtunnel construction methods could also be used for crossings of special facilities.

6.1.1.4. Construction Machinery and Equipment – Nearshore

The excavation of the nearshore pipeline trench will be performed by barge-mounted mechanical excavation equipment. The excavation would be supported by supply barges and tugboats. Artificial lighting equipment will be required for early morning or late afternoon operation during typical trench construction hours (7:00 a.m. to 7:00 p.m.).

Mechanical excavators, such as clamshell type equipment, are the most common types of equipment used in marine excavation and pipe laying applications. Selection of the type of equipment used to perform the excavation will depend on the following factors:

- Physical properties of the excavated material.
- Quantities of material to be excavated.
- Distance for transport to the disposal area.
- Presence and concentration of contamination.
- Equipment readily available to contractors.
- Cost.
- Turbidity impacts.

6.1.2. Trenchless Construction

Trenchless construction methods could also be utilized for both onshore and nearshore outfall pipeline segments. Trenchless construction activities include excavation of an access/launch shaft or pit, excavation of the tunnel bore, removal of excavated material, and advancement of the tunnel lining. Several trenchless construction method alternatives were presented in the Draft EIS (King County, 2002a). Microtunnel construction was selected from these alternatives based on evaluation presented in the *Nearshore Alignment and Construction Method Alternatives Technical Memorandum* (King County, 2003b).

As discussed previously, trenchless construction is not the preferred option, but may be used onshore and/or through the nearshore to minimize disturbance to areas of contaminated soil and/or groundwater and contact with areas of sensitive environmental resources. Microtunnel construction methods are discussed in the *Nearshore Alignment and Construction Method Alternatives Technical Memorandum* (King County, 2003b).

6.2. Offshore Construction Methods

The offshore segment of the proposed outfall alignments extends from the end of the nearshore segment (trench or tunnel) and terminates at the end of the diffuser. The offshore outfall segment will be placed directly on the seabed and will not require excavation. The diffuser segment will be installed along with the offshore pipeline utilizing the same offshore construction method.

Potential outfall alignments will cross known utility cable areas established by the United States Army Corps of Engineers (COE). As part of continuing predesign efforts, a desktop and/or field survey of the project area will be performed to locate and map existing underwater surface and subsurface cables or pipelines. Results of the desktop investigation and field survey mapping will be used to determine appropriate design provisions to ensure proper protection of cables, if any, during construction. Short, bridged sections of offshore pipeline can span identified in-water utility cables to prevent damage during outfall construction and operation.

Three potential offshore construction methods were identified during an Offshore Construction Methods Workshop held by King County in February 2002. At the workshop, construction methods were discussed in terms of construction activities, advantages/disadvantages, zone-specific applicability, and potential risks impacting cost and construction schedule. The evaluation of offshore construction methods is presented in *Offshore Construction Methods Workshop Technical Report* (King County, 2002d).

Depending on the offshore construction method selected, a land-based staging area may be required for fabrication of pipeline segments and storage of construction materials and equipment. The staging area may be located at the same staging area used for nearshore construction or may be located near a convenient offsite location near a sheltered harbor. Construction activities, both at the staging area and during offshore pipeline installation, would be as described in Sections 6.2.1 through 6.2.3 for each offshore construction method. Construction machinery and equipment includes tugboats, barges, welding equipment, cranes, flotation devices, and artificial lighting.

Pipeline installation methods for the offshore pipeline segment include segmental lay, controlled submergence, and/or bottom pull. Final selection of the offshore construction method will be based on availability of construction equipment and the individual contractor's level of confidence with each method.

6.2.1. Segmental Lay

Pipelines constructed by the segmental lay method require the use of divers and/or robotics to make underwater connections between pipeline segments as the pipes are placed on the seabed. Robotics would be used at water depths below approximately –200 feet MLLW due to limitations on diver time at such depths. Several barge mounted cranes would be used to lower pipeline segments (100 to 500 feet in length) while other barges would supply material to the working barge. Segmental lay construction would not require a nearby land-based staging area, as construction materials and equipment for support of pipeline installation could be supplied from

the water. A land-based staging area at a convenient offsite location would be necessary for assembly of the 100- to 500-foot pipe segments.

6.2.2. Controlled Submergence

The controlled submergence method involves the fabrication of the entire outfall pipeline either onshore or at a convenient offsite location in a sheltered harbor. The pipeline would be floated from land or the sheltered waters and towed into place at the desired outfall zone. Once in place, the pipeline would be lowered (sunk) in a controlled manner while being positioned to settle on the seabed starting from the nearshore and ending at the diffuser. Buoyancy of the outfall pipeline during towing could be accomplished by filling the pipeline with air or by utilizing flotation devices. The floating pipeline could be towed into place by multiple tug boats (one boat at each end of the pipeline) and intermediate vessels as determined necessary by the contractor.

6.2.3. Bottom Pull

Bottom pull involves the fabrication of long sections of pipeline onshore at the location where the connection will be made with the upland conveyance pipeline. These fabricated sections would be pulled offshore down the existing slope of Puget Sound to the outfall end point (diffuser location). The pull is facilitated by maintaining a small negative buoyancy (5 to 10 pounds per foot) of the pipeline because pulling a fully weighted pipeline along the seabed would disturb the seafloor substrate and organisms, abrade the pipeline coatings used for corrosion protection, and impose unnecessary flexing of the pipeline itself due to its own weight.

7.0 CONNECTION TO PLANT AND CONVEYANCE BRIGHTWATER SYSTEM COMPONENTS

7.1. Conveyance Tunnel Terminus (Zone 7S)

Outfall construction in Zone 7S will begin from the proposed conveyance tunnel portal location at Point Wells. The conveyance tunnel portal will be approximately 50 feet wide by 150 feet long and excavated up to approximately 40 feet below the ground surface. Construction of the tunnel portal and potential surface structures would be as described in the *Conveyance System Project Description Technical Memorandum* (King County, 2003d).

The proposed outfall connection to the conveyance tunnel portal will require a transition from the 96-inch-diameter conveyance tunnel to the 60-inch-diameter outfall pipeline. If cathodic protection (see Section 13.1) were utilized, it will also be necessary to isolate the tunnel pipeline from the outfall pipeline by means of an insulating joint/flange connection between the two pipelines.

Two proposed transition methods have been developed for connection of the conveyance and outfall pipeline as shown in Figures 5 and 6. The first alternative would utilize an excentric reducer inside of the portal structure while the second alternative would place the reducer outside of the portal structure. For either alternative, the transition will be below the ground surface and have a minimum space requirement of 12 feet by 16 feet. Depth of ground cover above the top of the outfall pipeline is anticipated to be between 20 and 24 feet.

7.2. Effluent Pump Station (Zone 6)

Outfall construction in Zone 6 will begin from the proposed effluent pump station location at the Unocal treatment plant site as shown in Figure 1. Construction of the effluent pump station and associated structures would be as described in the *Treatment Plant Project Description Technical Memorandum* (King County, 2003e).

The proposed outfall connection to the effluent pump station would consist of a flexible yet restrained connection as shown in Figure 7. The depth of ground cover above the outfall pipeline would be determined by existing utility lines in the project vicinity. It is anticipated that the outfall pipeline will be buried approximately 10 feet below the ground surface (trench depth up to 15 feet) for the onshore segment to avoid interference with utility lines and to provide adequate depth of cover below the BNSF railroad line. As with the proposed outfall connection at Portal Siting Area 19, the outfall pipeline may also require an insulated pipe joint/flange to isolate the outfall pipeline cathodic protection system.

8.0 OUTFALL ALIGNMENTS AND SEGMENT LENGTHS

8.1. General Alignment Description

Outfall alignments include the pipeline route from the onshore staging area to the shoreline, through the nearshore, and to the diffuser located approximately 5,000 feet from the shoreline. Potential outfall alignments have been identified within both Zones 6 and 7S, as shown in Figures 2 and 3, respectively. Construction alternatives and alignments originating from staging areas at the Unocal plant site effluent pump station (outfall Zone 6) and the conveyance tunnel terminus at Portal Siting Area 19 (outfall Zone 7S) were selected based on evaluation presented in the *Nearshore Alignment and Construction Method Alternatives Technical Memorandum* (King County, 2003b).

In general, open-trench and/or trenchless construction methods would be used to bury the pipeline onshore and through the nearshore up to a water depth of –80 feet MLLW. Offshore construction methods would be used to install the pipeline directly on the seafloor from the end of the nearshore segment to the diffuser location in water depths of –605 feet MLLW. The offshore outfall segment length would be 4,000 feet for the alignment in Zone 7S and 4,300 feet for the alignment in Zone 6. The diffuser segment length is anticipated to be 500 feet for all alignments.

A summary of outfall segment lengths for each of the outfall alignments is presented in Table 1.

Table 1. Outfall Alignment Segment Lengths

	Lower Point Wells (Zone 7S)	Unocal Plant Site (Zone 6)
Onshore Segment (ft)	1,000	1,000
Nearshore Segment (ft)	700	950
Offshore Segment (ft)	4,000	4,300
Diffuser Segment (ft)	500	500
Total (ft)	6,200	6,750

8.2. Lower Point Wells Alignment

Construction at the Lower Point Wells site is the preferred alternative for outfall pipeline construction in Zone 7S and the preferred Brightwater System alternative. Open-trench construction is the preferred method for installation of the outfall pipeline along the Lower Point Wells alignment. However, a combination of trench and/or microtunnel construction methods could be utilized that would minimize disturbance to areas of contaminated soil and/or groundwater and contact with areas of sensitive environmental resources. At this time, it is assumed that open-trench construction methods would be used both onshore and through the nearshore due to the suspected presence of subsurface sheet piling at the Chevron site and the potential for subsurface barriers both onshore and in the nearshore.

The Lower Point Wells alignment is as shown in Figure 3. Open-trench excavation and pipeline installation along the Lower Point Wells alignment would extend approximately 1,000 feet from the conveyance tunnel terminus to the tip of Point Wells just south of the existing dock. Onshore open-trench construction would likely use trench sheeting to minimize the volume of soils excavated from potentially contaminated areas. Construction would take place within the existing seawall up to the tip of Point Wells, where the trench would be constructed through the seawall and would continue approximately 700 feet through the nearshore to a water depth of approximately -80 feet MLLW. Trench sheeting would be utilized for nearshore open-trench construction up to -30 feet MLLW to minimize environmental impacts to nearshore habitat. Further use of trench sheeting through the nearshore will be determined through discussion with appropriate regulatory agencies and will depend on the extent of eelgrass beds and the soil conditions likely to be encountered. Beyond the trenched section, the offshore outfall pipeline (4,000 feet) and diffuser segment (500 feet) will be laid on the seafloor surface to a water depth of -605 feet MLLW.

8.3. Unocal Plant Site Alignment

Open-trench construction methods are preferred for outfall pipeline alignments originating from the proposed effluent pump station at the Unocal plant site alternative. As discussed for the proposed Lower Point Wells alignment, a combination of open-trench and/or microtunnel construction methods could be utilized that would minimize disturbance to areas of contaminated soil and/or groundwater and to recreational and/or commercial uses along the alignment. At this time, it is assumed that open-trench construction methods would be used both onshore and through the nearshore due to the potential for subsurface barriers both onshore and in the nearshore. The absence of known eelgrass beds would make tunneling under the nearshore less advantageous than proven open-trench construction methods.

The Unocal plant site alignment is as shown in Figure 2. Open-trench excavation and pipeline installation along the Unocal plant site alignment would extend approximately 1,000 feet from the proposed effluent pump station to the shoreline just north of the existing Unocal pier. Onshore open-trench construction will use trench sheeting to minimize the volume of soils excavated from potentially contaminated areas. A short segment, approximately 80 to 100 feet, of pipeline will be jacked under the BNSF railroad line located just west of the Unocal plant site.

From the shoreline, open-trench construction would continue up to 950 feet through the nearshore to a water depth of approximately -80 feet MLLW. Trench sheeting would be utilized for nearshore open-trench construction up to -30 feet MLLW to minimize environmental impacts to nearshore habitat. Further use of trench sheeting through the nearshore will be determined through discussion with appropriate regulatory agencies and will depend on the extent of eelgrass beds and the soil conditions likely to be encountered. Beyond the trenched section, the offshore outfall pipeline (4,300 feet) and diffuser segment (500 feet) will be laid on the seafloor surface to a water depth of -605 feet MLLW.

9.0 DIFFUSER DESIGN

Current diffuser design is based on the evaluation presented in the *Diffuser Predesign Technical Memorandum* (King County, 2003c), which summarized the results of outfall and diffuser siting studies, dilution modeling, and engineering design analyses. The present level of design has assumed a diffuser port configuration based on King County's existing South Treatment Plant Outfall, which includes diffuser segments with 168 evenly spaced 4-inch ports. Installed at a water depth of -605 feet MLLW and at a length of 500 feet, the assumed port configuration will meet all County identified diffuser design criteria for dilution, effluent transport, and hydraulic performance.

The analyses discussed in the *Diffuser Predesign Technical Memorandum* (King County, 2003c) show that diffuser port configuration has only a minor impact on far-field dilution and transport of the discharged effluent. Additional model analyses of diffuser port configuration over the range of design flows and evaluation of diffuser design features will be completed during predesign. This evaluation will optimize diffuser performance characteristics to meet the identified criteria.

Although periodic outfall maintenance activities will be required, the marine outfall and diffuser will be designed for automatic operation. Several design features could be utilized to minimize maintenance requirements and maintain proper operation over its design life, including check valves, a self-cleaning end port, and diffuser port risers.

Check valves are used to prevent seawater intrusion. The valves progressively open as effluent flow increases and remain closed in the absence of effluent flow. Check valves may be warranted if low flow periods below 18 mgd occur at plant startup or due to increased distribution of reclaimed water.

Risers are used to extend those diffuser ports installed directly in the wall of the diffuser pipeline. The natural sedimentation of material at the seafloor or settlement of material below the diffuser may necessitate the use of risers to prevent diffuser port burial over the design life of the outfall. Sedimentation and settlement rates will be determined as part of continuing predesign efforts.

Self-cleaning end ports are commonly used in diffuser designs. These ports often have an invert elevation that is the same as the diffuser pipeline and are used as a means of scouring accumulated sediment from the diffuser pipeline during higher flow periods.

Diffuser design features will be selected based on a review of Maintenance Reports for existing King County outfalls and port configuration optimization determined through additional diffuser modeling.

10.0 PIPELINE SIZE AND MATERIALS

Predicted Brightwater System flows range from 18 million gallons per day (mgd) at initial Average Dry Weather Flow (ADWF) to a peak flow of 235 mgd, as discussed previously in the *Treatment Plant Project Description Technical Memorandum* (King County, 2003e). Based on estimated Brightwater System flows, the outfall pipeline hydraulic analysis presented in the *Brightwater Marine Outfall Conceptual Design Report* (King County, 2002c), and predesign hydraulic analyses, a single 60-inch outfall and diffuser pipeline have been selected. Selection of the pipeline material is dependent upon construction method, as well as structural analyses based on the anticipated installation and operation stresses imposed on the pipeline. Structural analyses to facilitate final material selection will be performed during future predesign work.

The pipeline material most commonly selected for recent marine outfall installations is highdensity polyethylene (HDPE). The flexibility of HDPE pipeline is advantageous for traversing irregular seafloor conditions. HDPE is also resistant to the corrosive effects of seawater and attack by marine organisms. However, the buoyancy of HDPE pipeline necessitates the use of external weights (typically cement collars) to hold it in place and prevent it from floating and/or moving due to hydrodynamic forces. The combined effects of HDPE material flexibility and low bending strength indicate that the pipeline would require closely spaced weights (10- to 15-foot spacing) in order to offset buoyancy. Potential changes to the seabed due to liquefaction or landslide may cause loading of the pipeline and thrust against the anchor weights. These loads could damage the pipeline or cause localized floating of the pipeline.

Due to the sloughing and landslide concerns in the project area, the most suitable material for the outfall pipeline would be steel. Steel is best suited to meet the stress relationships created by changing seafloor conditions after construction. If the pipeline were constructed of steel, protective coatings (outside of the pipe) and linings (inside of the pipe) will be applied to the pipeline prior to installation to prevent corrosion of the pipeline. Abrasion coatings will also be applied to protect the pipeline during installation and over the design life of the outfall. Corrosion protection for steel pipelines will also be provided by an impressed current cathodic protection system as discussed in Section 13.1.

11.0 CONSTRUCTION EXCAVATION AND BACKFILL MATERIALS

Soils excavated by land-based open-trench and trenchless construction equipment would be disposed at regulated landfill sites selected based on the presence, if any, and concentration of contaminants in the excavated soils. Soils excavated by barge-mounted equipment during nearshore open-trench construction would be disposed at aquatic disposal sites regulated by the United States Army Corps of Engineers (COE). The exact location of the disposal site will be determined through the permitting process. Materials must meet contamination levels below those promulgated by the Puget Sound Dredge Disposal Analysis (PSDDA).

The excavated trench will be backfilled with bedding material, granular fill, and armoring material. Bedding material provides a level surface on which the pipeline rests in the trench. Armoring of the pipeline may be necessary from the shoreline to water depths of approximately –50 feet MLLW. Armoring is provided to protect the pipeline from wave action, erosion, and anchor damage. Granular fill is used to backfill the bulk of the remaining trench. The backfill material will be selected based on full consideration of the nature of existing soils, current conditions, and historical evidence of erosion. Trenchless construction and offshore construction will not require backfill materials.

The anticipated volume of excavated soils and backfill materials for each of the potential alignments are provided in Table 2. The volumes in Table 2 assume sheeted trench construction onshore and unsheeted trench construction through the nearshore to □80 feet MLLW. The onshore trench along the proposed Lower Point Wells alignment could be up to 30 feet deep based on the depth of the proposed land-based conveyance tunnel portal. The onshore trench along the proposed Unocal plant site alignment could be up to 15 feet deep. The nearshore trench could be up to 15 feet deep and armored to –50 feet MLLW. Offshore pipeline installation would not require excavation or backfill material. Trench cross sections are as shown in Figure 4.

The anticipated volumes in Table 2 assume the highest value within the range of potential widths, depths, or lengths for trench construction. Actual excavation volume is likely to be less than that shown in Table 2. Excavation volume would be further reduced assuming sheeted trench construction was used through the nearshore. Use of trench sheeting through the nearshore will depend on the extent of eelgrass beds and the soil conditions likely to be encountered. The volume of required granular backfill material could be reduced if native excavated soils were used as backfill.

Table 2. Anticipated Excavation and Backfill Volumes

	Lower Point Wells	Unocal Plant Site
Excavation		
Onshore (cy)	12,000	6,600
Nearshore (cy)	18,000	24,400
Total (cy)	30,000	31,000
Backfill		
Onshore (cy)	11,500	6,050
Nearshore (cy)	17,500	23,650
Total (cy)	29,000	29,700

Soils excavated on land would be transported to regulated landfill sites by dump trucks with a typical capacity of 16 cubic yards (cy). Backfill materials used for on-land construction activities would also be supplied by dump trucks. Barges with a typical capacity of 1,500 cy would be utilized for in-water transportation of excavated soils and backfill materials. Truck and barge routes for material delivery and soils disposal will be determined based on the location of disposal sites and construction staging areas.

12.0 CONSTRUCTION DURATION

Assuming no significant delays (inclement weather, accidents, and construction material supply difficulties) are encountered, total time of actual construction (not including material and equipment procurement) for all potential outfall and diffuser pipeline alignments is estimated at 10 to 12 months. An additional 6 to 12 months may be required for pipe delivery and procurement of specialized equipment.

The sequence of construction activities relative to different areas of the outfall alignment (onshore, nearshore, and offshore) is dependent upon the construction method, outfall staging area and alignment, and contractor preference. Typically, mobilization, material, and equipment delivery would begin 1 to 3 months before the start of the open-trench or tunnel construction. Material and equipment delivery are likely to continue concurrently with other open-trench, tunnel, and offshore construction activities. Construction of the offshore segment could proceed concurrently with the nearshore and onshore work. Restoration and demobilization typically occur as construction segments are completed. These activities may proceed for an additional 1 to 2 months after the other construction activities are completed.

Preliminary construction schedule estimates for trench, tunnel, and offshore construction activities are presented in Table 3. Duration estimates given as a range in Table 3 reflect differences in pipeline length for the potential outfall alignments. Because some construction activities could take place at the same time, total construction duration is not the sum of the individual activities.

Table 3. Preliminary Construction Schedule Estimates

Activity	Duration (months)
Trench Construction	
Material/Equipment Delivery	2
Mobilization	1-2
Dewatering	2
Onshore Trench	1-2
Nearshore Trench	2-3
Demobilization/Restoration	1-2
Tunnel Construction	
Material/Equipment Delivery	2-3
Mobilization	1-2
Tunnel Boring	4-5
Demobilization/Restoration	1-2
Offshore Construction	
Material/Equipment Delivery	4-5
Mobilization	1-2
Pipeline Fabrication/Installation (Controlled Submergence and Bottom Pull)	2-3
Pipeline Fabrication/Installation (Segmental Lay)	4-6
Demobilization/Restoration	1-2

Daily construction schedules differ for the potential construction methods. Construction during daylight hours (7:00 a.m. to 7:00 p.m.) would minimize the need for artificial lighting. Construction areas and barges may still utilize lighting for security, navigation, or operational purposes outside of typical construction hours. Although tunneling operations would require continuous construction (24 hours a day), a significant portion of tunneling activities would take place below the ground surface.

Typical construction hours for the potential construction methods would be as follows:

- Trench – Primarily daylight hours.
- Tunnel – Continuous construction.
- Segmental Lay – Primarily daylight hours.
- Controlled Submergence – Primarily daylight hours (pipe fabrication) and continuous construction for up to 1 week (pipeline installation).
- Bottom Pull – Primarily daylight hours (pipe fabrication) and continuous construction for up to 4 weeks (pipeline installation).

13.0 OUTFALL OPERATION AND MAINTENANCE

13.1. Planned Maintenance Activities

The outfall and diffuser will be designed to meet performance criteria, discussed in Section 4.0, at all flows throughout the predicted range of Brightwater System flows (18 to 235 mgd). The outfall and diffuser will operate automatically, but will require periodic maintenance of the outfall pipeline and diffuser to evaluate structural integrity, hydraulic performance, and meet anticipated permitting requirements. Outfall maintenance would include visual inspection either by divers or robotics and would be performed approximately every 5 years and after significant seismic events. The inspection crew would check the pipeline for slide, anchor, or other damage and make certain that diffuser ports were free from blockage caused by accumulation of biological growth.

In the long term, the outfall and diffuser may require an interior inspection and cleanout as was performed for King County's West Point Treatment Plant Outfall. The interior cleanout would identify potential blockage due to accumulated solids present in the outfall and the interior inspection would reveal the structural integrity of the pipeline. Due to the level of wastewater treatment provided by the proposed Brightwater System and potential "self-cleaning" diffuser design, it is likely that solids would accumulate in the outfall and diffuser at a very slow rate, if at all.

If the pipeline were constructed of steel, an impressed current cathodic protection system will be used to prevent corrosion of the pipeline. Impressed current systems are based on an external source of current (cathodic protection rectifier) to reverse corrosion currents. The rectifier is connected to the pipeline, as well as a group of buried metal rods that are sacrificially corroded instead of the pipeline. The current King County maintenance schedule for cathodic protection systems on other outfalls includes quarterly monitoring of the rectifier and monitoring of the current interceptors every 5 years.

Table 4 presents a preliminary estimated frequency of potential maintenance activities.

Table 4. Potential Maintenance Activities

Activity	Frequency
Cathodic Protection System Monitoring	
Rectifier	Quarterly
Current Interceptors	Every 5 years
Exterior Visual Inspection (including offshore pipeline and diffuser)	Every 5 years (and after significant seismic events)

13.2. Planned Monitoring Activities

King County routinely monitors the receiving environment in the vicinity of its wastewater treatment system marine outfalls. The county's National Pollutant Discharge Elimination System (NPDES) permits for existing wastewater treatment system outfalls require the periodic collection of subtidal marine sediment samples for chemical analysis. This sediment monitoring is conducted in accordance with the Washington State Sediment Management Standards (Chapter 173-204 WAC). In addition to the sediment monitoring required under the NPDES permit, the county also conducts additional, voluntary monitoring of the benthic community around its outfall diffusers, the water column above its outfall diffusers, and intertidal water, sediment, and biota in the vicinity of its outfalls. Both the NPDES and voluntary monitoring programs receive annual review and are periodically updated to incorporate both new requirements of the NPDES program and suggestions and recommendations from the Washington State Departments of Ecology (Ecology), Fish and Wildlife (WDFW), and Health (DOH), as well as the National Marine Fisheries Service (NMFS) and United States Department of Fish and Wildlife (USDFW).

King County proposes to conduct similar monitoring for the Brightwater outfall. The monitoring plan for the Brightwater outfall will incorporate all requirements of the eventual treatment system NPDES permit. Voluntary monitoring would consider suggestions and recommendations from Ecology, WDFW, DOH, NMFS, and USDFW and would be designed to use the latest monitoring technologies. The Brightwater voluntary monitoring program, like those for the county's other wastewater treatment system outfalls, would be flexible and undergo periodic review to validate its effectiveness.

Based on NPDES requirements for its existing wastewater treatment system outfalls and its current voluntary monitoring programs, King County proposes a monitoring program for the Brightwater outfall that would incorporate the following elements:

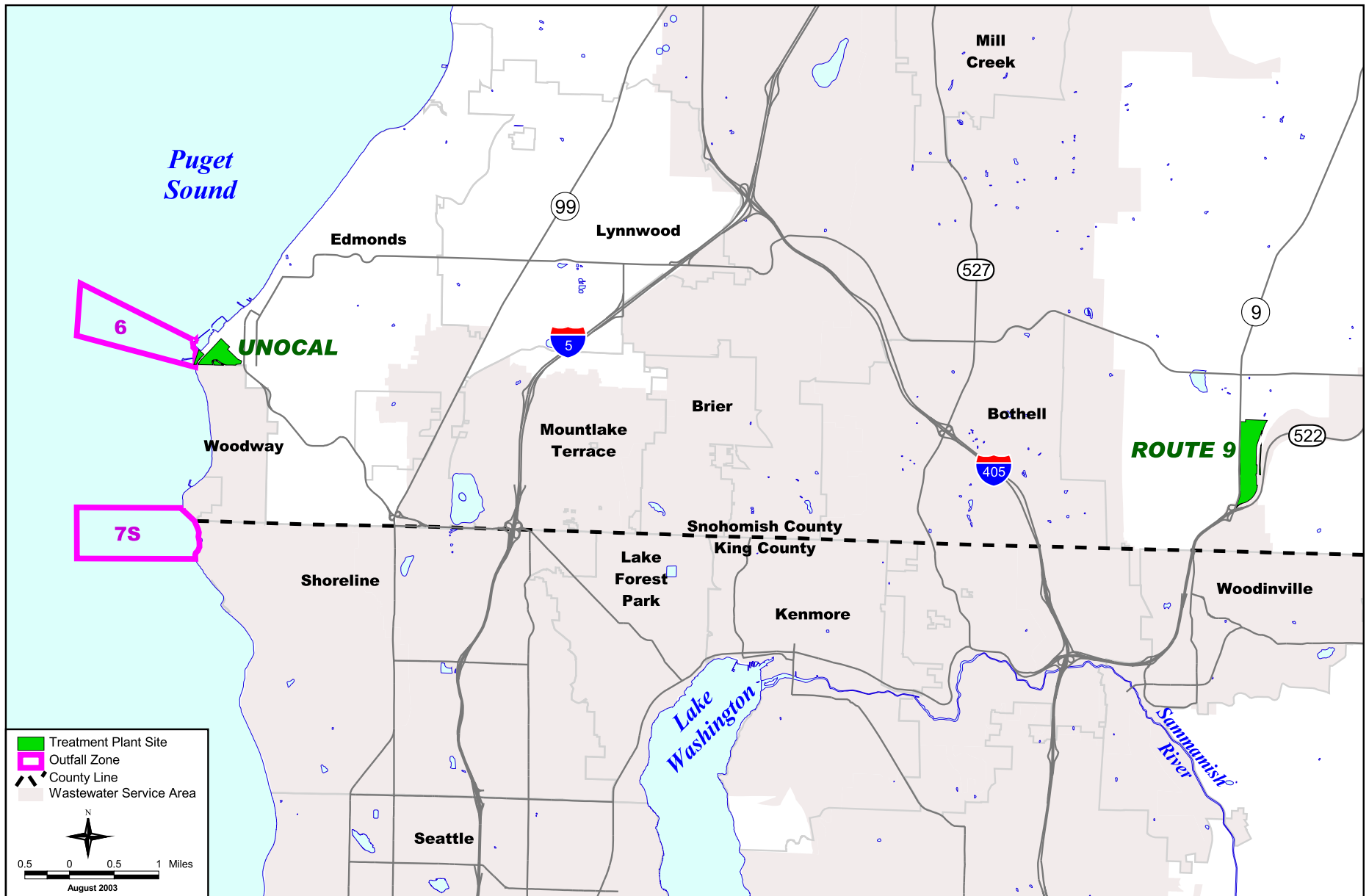
- Collection of subtidal marine sediment samples at the outfall diffuser once per NPDES permit cycle for analysis of chemical parameters and the benthic community.
- Collection of water column samples above the outfall diffuser on a monthly basis for analysis of bacteria, nutrients, dissolved oxygen, turbidity, and suspended solids.
- Collection of intertidal water samples in the vicinity of the outfall on a monthly basis for analysis of bacteria and nutrients.
- Collection of butter clam tissue samples from beaches in the vicinity of the outfall on a monthly basis from May through September for analysis of bacteria.
- Collection of butter clam tissue and intertidal sediment samples from beaches in the vicinity of the outfall on an annual basis for analysis of trace metals and organic chemicals.
- Collection of algae samples from beaches in the vicinity of the outfall on an annual basis for analysis of trace metals.

Planned monitoring activities are discussed in the *Proposed Routine Monitoring Plan for the Receiving Environment in the Vicinity of the Brightwater Treatment System Marine Outfall* (King County, 2003f).

14.0 REFERENCES

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- King County. 2003d. *Conveyance Project Description Technical Memorandum*. Seattle, Washington.
- King County. 2003e. *Treatment Plant Project Description Technical Memorandum*. Seattle, Washington.
- King County. 2003f. *Proposed Routine Monitoring Plan for the Receiving Environment in the Vicinity of the Brightwater Treatment System Marine Outfall*. Seattle, Washington.

Figures



King County
Department of
Natural Resources and Parks
**Wastewater Treatment
Division**

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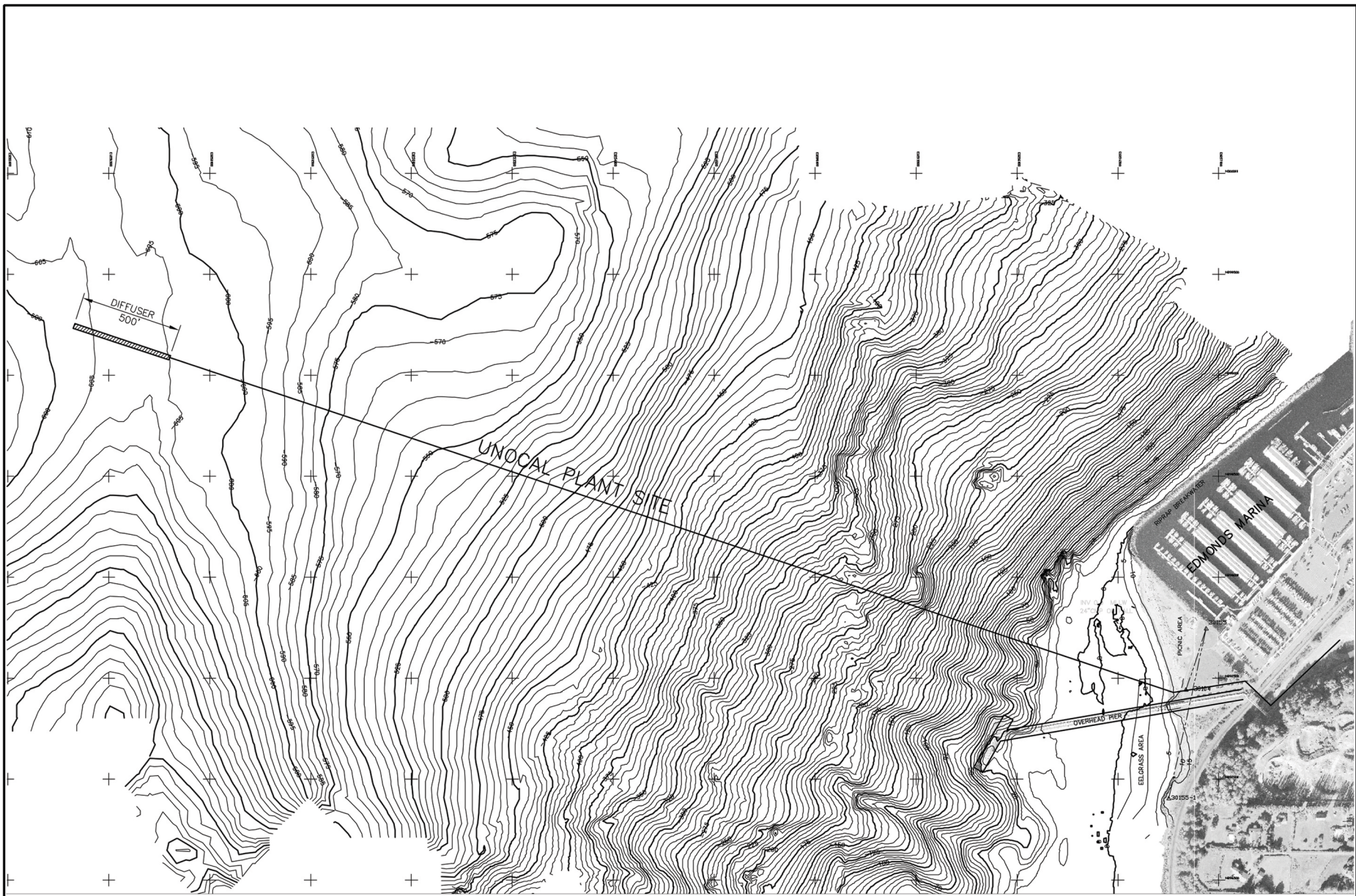
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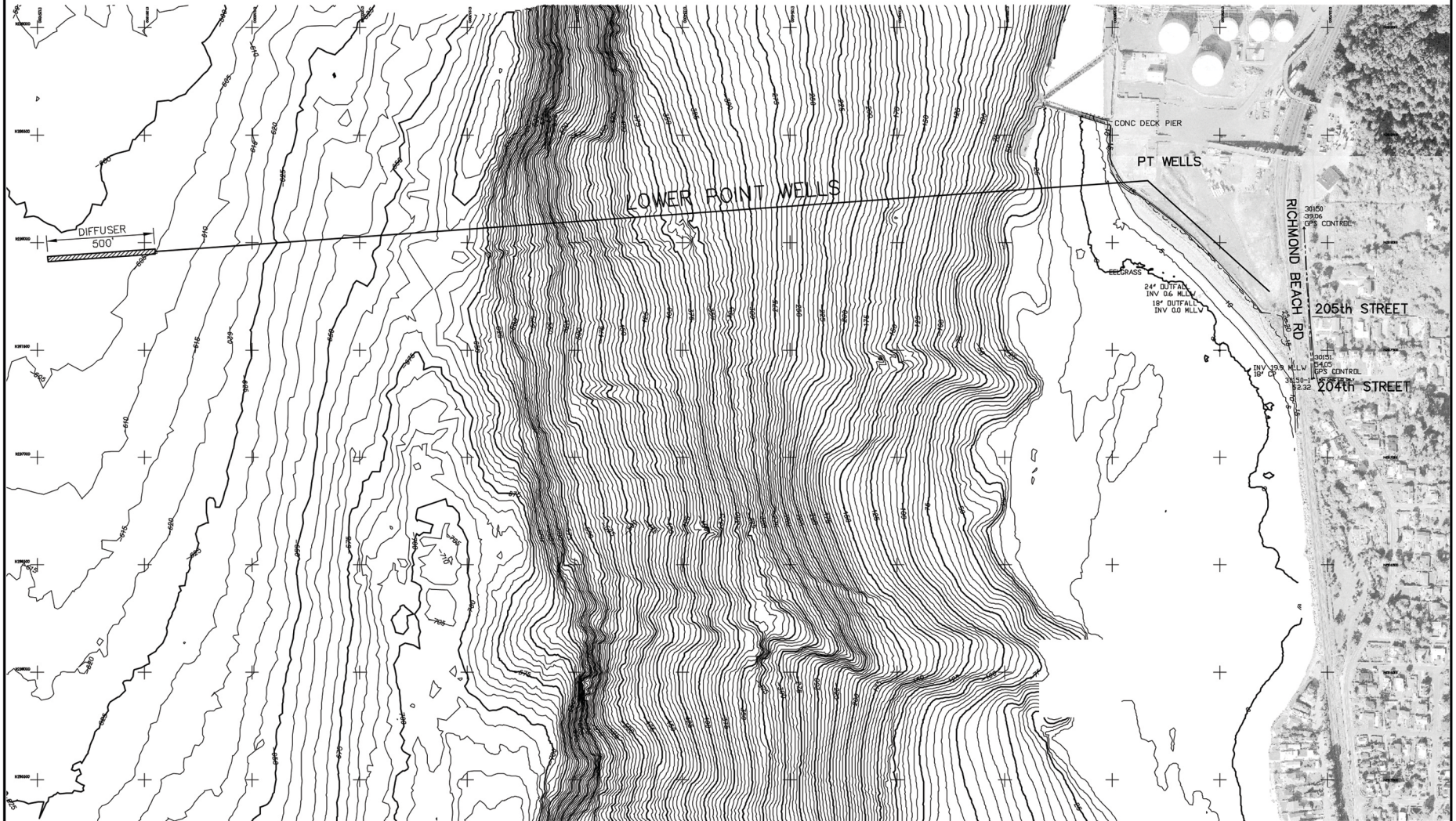
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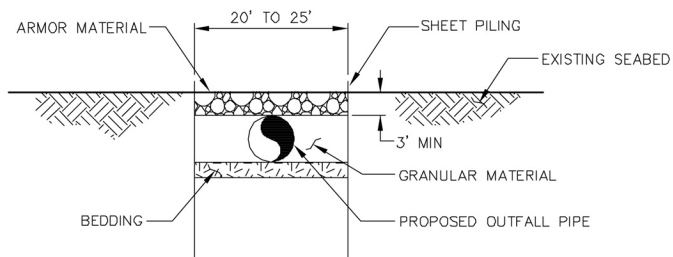
Figure 1

Brightwater System Project Area Including Outfall Zones 6 and 7S

*BRIGHTWATER REGIONAL
WASTEWATER TREATMENT SYSTEM*

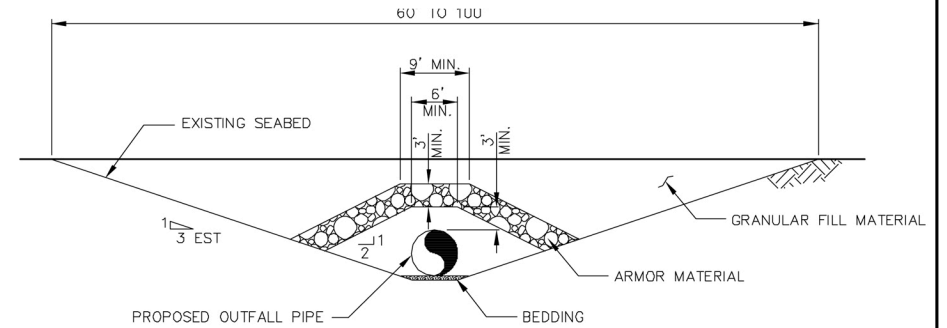






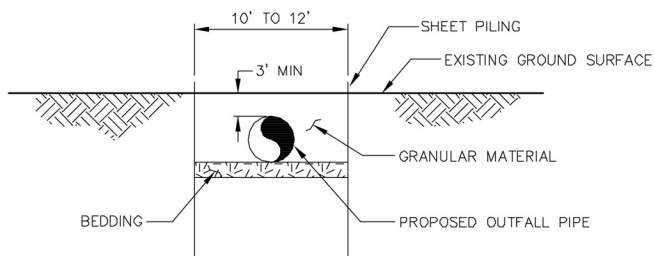
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